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(54) **Multi-station bus system having means for polling and updating of globally relevant information, in particular a station address, and station for use in such system.**

(57) A communication system has multiple and uniformly weighted station interconnected by a shared digital bus. A particular station comprises globally relevant information, and, with a predetermined maximum recurrence time, transmits a data packet representing such item to any other interested station. If unanimous counter signalization occurs, the item is in order, other wise updating thereof is undertaken. The unanimity is either by positive signalization, or by default.

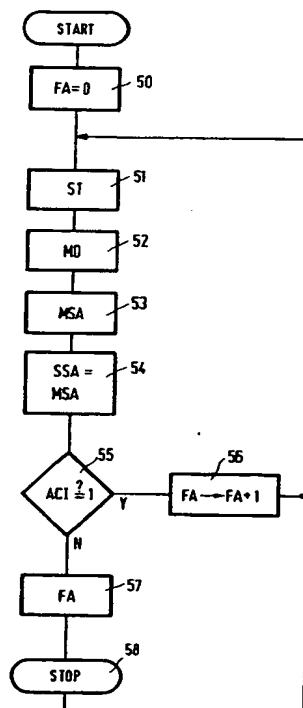


FIG. 3

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## FIELD OF THE INVENTION

The invention relates to a communication system having multiple and uniformly weighted stations that are interconnected by a shared digital bus. Such systems are in general use. Uniformly-weighted is understood as meaning that there is no single station present that acts as overall controller of the bus interactions. On the level of a single transfer, a first station may operate as master, whereas one or more second stations would operate as slaves. A subsequent transfer could then have a different master station. Moreover, the stations can have various different priority levels, activity frequencies, and hardware provisions. The bus as referred to supra is metaphoric for its medium, that may be single- or plural channel, galvanically interconnected, optical, radio broadcast, infrared, or other. The bus medium may be uniform or mixed, such as a wired interconnection, that has a two-way station for external communication of infrared signals. The organization may have provisions for AND-ing/OR-ing logical states generated by the bus-connected stations. In other organizations, such provision would be irrelevant. Now, the nature of the stations may be various, but a particular field of use would be home-based systems. In that case, the stations could be devices for audio/video entertainment, home-environmental control (lighting, temperature, humidity), devices for executing household chores, telecommunication, safety control, or other. A particular hazard of such system is the low degree of organizational consistency on the level of the stations themselves, as exemplified by:

- a particular station may be temporarily deactivated, which may be effected by unplugging from the bus, switch-off by an associated main switch, by disconnection of its mains plug, or other. Of course, the bus' physical transport layer should be immune against such disruption, but higher protocol levels would at any rate be influenced;
- a particular message could go astray, which in particular could occur in case of an infrared or broadcast medium. Such could cause various levels of inconsistency, in that certain stations could receive information that differs from other stations' information, or could even be totally absent;
- at arbitrary instants the bus system could become connected to another bus system. Even if at each level of the separate bus system consistency would prevail, such need no longer be the case on the level of the composite system.

## SUMMARY OF THE INVENTION

Amongst other things, it is an object in the present invention to solve in particular in, but not limited to home systems, the above inconsistency problem in a convenient, consistent and unencumbering manner. According to one of its aspects, the invention solves the problem in that it is characterized in that a particular station comprising a globally relevant information item comprises means for, recurrently with a predetermined maximum recurrence interval transmitting a data packet representing such information item for unanimous counter signalization thereto by at least a relevant subset of actually interconnected stations thereto, but upon absence of such unanimous counter signalization initiating an updating action with respect to its own relevant information item. In particular, the originating station does not address the stations of the relevant subset, because it would not be sure which stations would actually be present in the subset; it would only know that any station not joining in the unanimous counter signalization, whereas it should actually have joined indeed, thereby signals that the originally transmitting station had an information that were outdated or otherwise erroneous. Thereupon, the original station starts with updating. The unanimous counter signalization indicates, that all other stations are in unison about the original information item. The physical representation of the unanimity may be various, such as by wired-OR (a -one- signal could in particular circumstances signal a discord), or wired-AND. The counter signalization can be as well by a message, wherein the set of messages generated would indicate unanimity or otherwise. In this respect, all messages could indeed contain identical signalization items, whereupon the original station would check the unanimity. According to another solution, any such message could, on a suitable communication layer, such as bit, word, or other, by its occurrence alone, signal lack of unanimity. Furthermore, the original station need not always transfer the item itself, but also an indirect indication, abstract, or other representation could suffice. It is not strictly necessary that all other stations connected should actually have the facility for counter signalizing. Certain stations could be slave-only stations. Alternatively, a station could be too busy to answer. If it would not concur with the unanimity, it could signal so upon the end of the next recurrence interval. Various other reasons could put a particular station out of the relevant subset specified above.

According to a particular advantageous aspect of the invention, the globally relevant information is an address of the particular station itself. Generally, such addresses should be unique, and the updat-

ing would take care of making the address unique again. Various effects could cause two or even more stations to have the same address, and the present invention would make the system stabilized again on a unique address for all stations that would observe the polling operation. Another globally relevant information would be a value of the actual or real time. The invention would keep the actual value thereof correct, even if the original station would become temporarily disturbed and would not know which other station to address for acquiring the correct value.

If the original station broadcasts its own address as destination address, any other station responding thereto would mean non-unanimity with respect to other stations that would keep mum. In this respect, the situation that all stations had the same address is considered as degenerate. In practice, it will not occur.

The updating may go according to a predetermined pattern. For an address, successive incrementations by one would be good. Alternatively, updating according to a pseudo-random series would keep two updating stations apart from each other. Especially in a start-up situation where any station may start from a default address -zero-, this would be advantageous: respective stations could then follow respective different sequences.

After updating, the result of the updating may be signalled to any relevant station, either by repeating transmitting a data packet formatted like the original one, but with the now updated information item, or by effectively addressing any station present, for example, by adding destination default address such as -zero-. This procedure keeps other stations abreast of any new developments.

Advantageously, the system comprising distinguishing means for distinguishing among actual recurrence intervals of respective ones among said stations. Each station could have its own specific recurrence interval. Alternatively, the recurrence interval could be a time-variable quantity in any relevant station.

The invention also relates to a station for use in such communication system. Various advantageous aspects are recited in dependent Claims.

#### BRIEF DESCRIPTION OF THE FIGURES

Figure 1 shows diagrammatically the general structure of a single-channel communication system;

Figure 2 shows diagrammatically the communication operation performed on the communication bus;

Figure 3 shows a flow chart for assigning a station address to a station.

#### DESCRIPTION OF A PREFERRED EMBODIMENT

##### General structure of the communication bus system

Figure 1 shows diagrammatically a single-channel communication bus system. It comprises a communication bus 1 consisting of two data lines 11 and 12. In this case three stations 2, 3 and 4 are connected to this communication bus. Each station comprises an apparatus 21, 31, 41 which is connected to the data lines 11 and 12 by means of an interface circuit 22, 32, 42. Such an apparatus may be a TV monitor, a video recorder, an audio recorder, an audio tuner, a controllable set of lighting elements, etcetera. The communication bus is intended to transmit control signals from a first station to a second station. Some stations will act as master stations and others as slave stations. Some stations will act as transmitters of data, some as receivers. All kind of mixed or alternating situations are possible. The communication operations on the communication bus, which will herein be described, are performed by the interface circuits. A particular advantageous realization of the bus is D<sup>2</sup>B, c.f. US patent ..... that is single channel, twisted pair. The interface circuit may be a MAB 8051 microcontroller, referred to in: Single-Chips 8-Bit Microcontrollers, User manual 1988, Philips Electronic Components and Materials Division; Chapter 3: The MAB 8051/C51/52 microcontroller family; Chapter 11: The D<sup>2</sup>B specification. To distinguish the different stations, each interface circuit has a memory location 23, 33, 43 in which a station address is stored. A typical station address comprises twelve bits.

The structure of a communication operation on an information level is shown in Figure 2A. Such an operation starts with a start bit ST. It is followed by a mode field MO in which three mode indication bits are transmitted. They indicate the rate at which the following information will be transmitted. In master station address field MSA the twelve-bit master station address is transmitted from the station wishing to transmit information to a destination station. The twelve-bit destination station address is transmitted in the destination station address field SSA. If a station recognizes the destination address as its own address, it transmits an acknowledge code in acknowledge code field ACI. If this acknowledge code is not received, it means that the destination station is not present or does not function or that the destination station address is received in a mutilated form. No distinction is made between these three possibilities. In these cases the communication is discontinued after the acknowledge code field. If the acknowledge code has effectively been received, the master station trans-

mits a control code of, for example four bits in control field CF. After reception of this control code, the destination station again transmits an acknowledge code in acknowledge code field ACII. If this second acknowledge code is not received by the master station, the communication is discontinued. If the master station has received this second acknowledge code a data field DF occurs. The data field may be divided into various data or command subfields, each containing a data byte DB, and end of data signalization EOD, and acknowledge bit interval ACIII. Absence of the latter may trigger repeat of the most recent subfield. If EOD is positive, the transmission may terminate.

The structure of a station address is shown at Figure 2B. It comprises a service address SA, a type address TA and a follower address FA. The service address SA comprises, for example four bits and can thus distinguish sixteen services, for example an audio-video service, a washing service, a cooking/baking service etcetera. The type address TA comprises, for example five bits so that thirty-two stations can be distinguished within one service. For example, within the washing service a distinction can be made between a washing machine, a drier, a dish washer, etcetera and within the audio-video service a distinction can be made between a TV monitor, a tuner, a video recorder, etcetera.

In practice the user may have a number of apparatuses of the same type; for example, two or more video recorders. The follower address FA enables him to distinguish between these apparatuses of the same type. By three bits, eight apparatuses of the same type can be distinguished.

#### The initialization

Now, a station address comprises a service address, a type address and a follower address. Service address and type address have been assigned by a manufacturers which has programmed them in the station address memory of the interface circuit. Programming of the follower address will be left to the user and does not take place until after the relevant apparatus has been connected to the communication bus 1 by means of the interface circuit. To this end this interface circuit has an initialization program with the steps shown in Figure 3 and which is performed as soon as the apparatus is switched on. More particularly the follower address FA is set to zero in a first step 50. Subsequently the start bit ST is set on the communication bus in a step 51, the mode bits of the mode field MO in a step 52, subsequently the station address MSA of this station is set with FA=0 in a step 53 and finally the destination

station address SSA of the destination station with which communication is desired is set in a step 54. More particularly, the destination station address SSA is made be equal to the station address MSA of this master station. Waiting for an acknowledge code takes place in a step 55. If this code occurs in the acknowledge code field ACI (so that ACI=1), the follower address is raised by one in a step 56 and the steps 51 to 55 are performed again. Whenever an acknowledge code occurs (ACI=1) this means that another station is connected to the communication bus which has the same service address, type address and follower address as the transmitting master station. As soon as no acknowledge code is received, this means that none of the other stations has a station address which corresponds to that of this master station. The last used follower address FA is then stored in the station address memory in a step 57, with which this initialization program comes to an end.

As described in the Reference, a master station does not get access to the communication bus until a so-called arbitration procedure has been formed. In this arbitration procedure the mode indication bits, the service address bits and type address bits and now also the follower address bits are involved.

#### The updating

In a system according to the invention, the stop block actually starts a particular time-out, after which the system again reverts to block 51, and the same procedure as for initialization ensues. A particular provision, not shown, may be taken in case the loop of Figure 3 were cycled continuously, because in that case no free address would be available. For brevity this has not been shown in Figure 3.

A few assumptions are as follows: first, any unit has a unique code UI or some "random" generator for distinguishing itself from units of the same sort. As almost any unit must contain some NVRAM already, this memory may also contain such code. The randomness of the randomness generator need not be extreme, inasmuch as any system usually contains only a moderate number of stations, say less than 50. Further, as long as a unit has not gained an address definitely, that is, when the unit has not yet decided which address to take, it may not respond to packets destined to its provisional address. Now, at the end of the time-out, the station leaves block 58 for block 51. Each station may have its own time-out value, or a time-out value that is randomized among successive passages through block 58. Also, the incrementing by 1 in block 56 may be changed into a quasi-randomized sequence of proposed station addresses.

A suitable solution is by a maximum-length retro-coupled shift register because this couples the quasi randomness with the property that all addresses will be actually passed.

Now, each unit will only try to get a unanimous counter signalization not too often. A right percentage is that overall load is at most 5%. On the other hand, user granularity must feel little influence of the incorrect addresses. It is felt that an interval wherein an incorrect interval could prevail should not be much more than one minute in a home system. This could mean that the time-out should be a fraction of a minute.

Particular globally relevant informations would be:

- the particular station's opinion of the content of other station's information, cf. the global real time referred to supra
- the wish to use a particular resource. Normally, the resource itself (peripheral, bus transport facility) is interrogated directly, but the present solution allows for a more abstract or ephemeral wish, without specifying the object itself.

#### Claims

1. A communication system having multiple and uniformly weighted stations that are interconnected by a shared digital bus, characterized in that a particular station comprising a globally relevant information item comprises means for, recurrently with a predetermined maximum recurrence interval transmitting a data packet representing such information item for unanimous counter signalization thereto by at least a relevant subset of actually interconnected stations thereto, but upon absence of such unanimous counter signalization initiating an updating action with respect to its own relevant information item.
2. A communication system as claimed in Claim 1, wherein said globally relevant information is an address of the particular station itself.
3. A communication system as claimed in Claim 1 or 2, wherein any physical counter signalization actually occurring means non-unanimity.
4. A communication system as claimed in Claim 2, wherein the data packet contains said address as a destination address and said unanimity represents an unresent signalization.
5. A communication system as claimed in Claim 2 or 4, wherein said updating action is generating a new address according to a predetermined

mined updating pattern.

6. A communication system as claimed in any of Claims 1 to 5, wherein said updating is followed by signalling result of said updating to any other relevant station.
7. A communication system as claimed in any of Claims 1 to 6, and comprising distinguishing means for distinguishing among actual recurrence intervals of respective ones among said stations.
8. A communication system as claimed in any of Claims 1 to 7, wherein said digital bus is single channel.
9. A communication system as claimed in any of Claims 1 to 8 and configured as a home system.
10. A station interfaceable to a communication system as claimed in any of Claims 1 to 9 and having accommodating means for accommodating a globally relevant information, transmission means for recurrently with a predetermined maximum recurrence interval transmitting a data packet representing such information item, detection means for thereupon detecting unanimous counter signalization as emanating from other stations connected, and updating means for under absence of said unanimous counter signalization updating said information item.

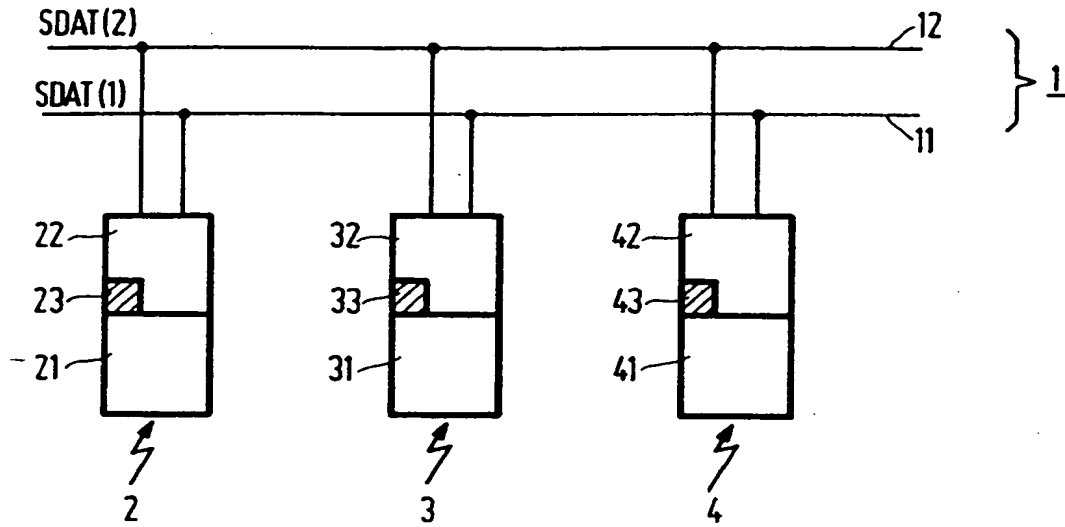


FIG. 1

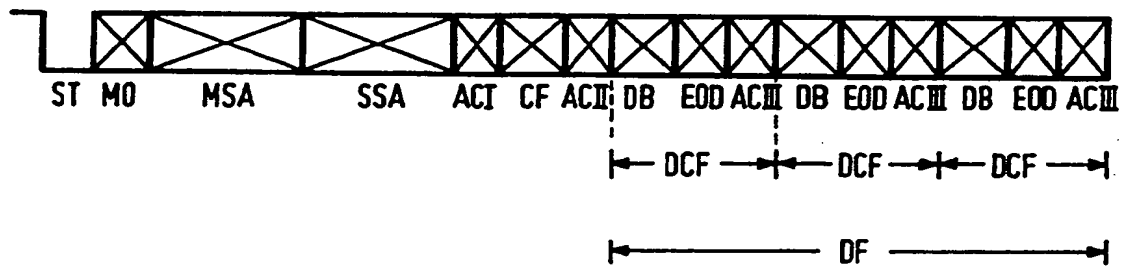


FIG. 2A



FIG. 2B

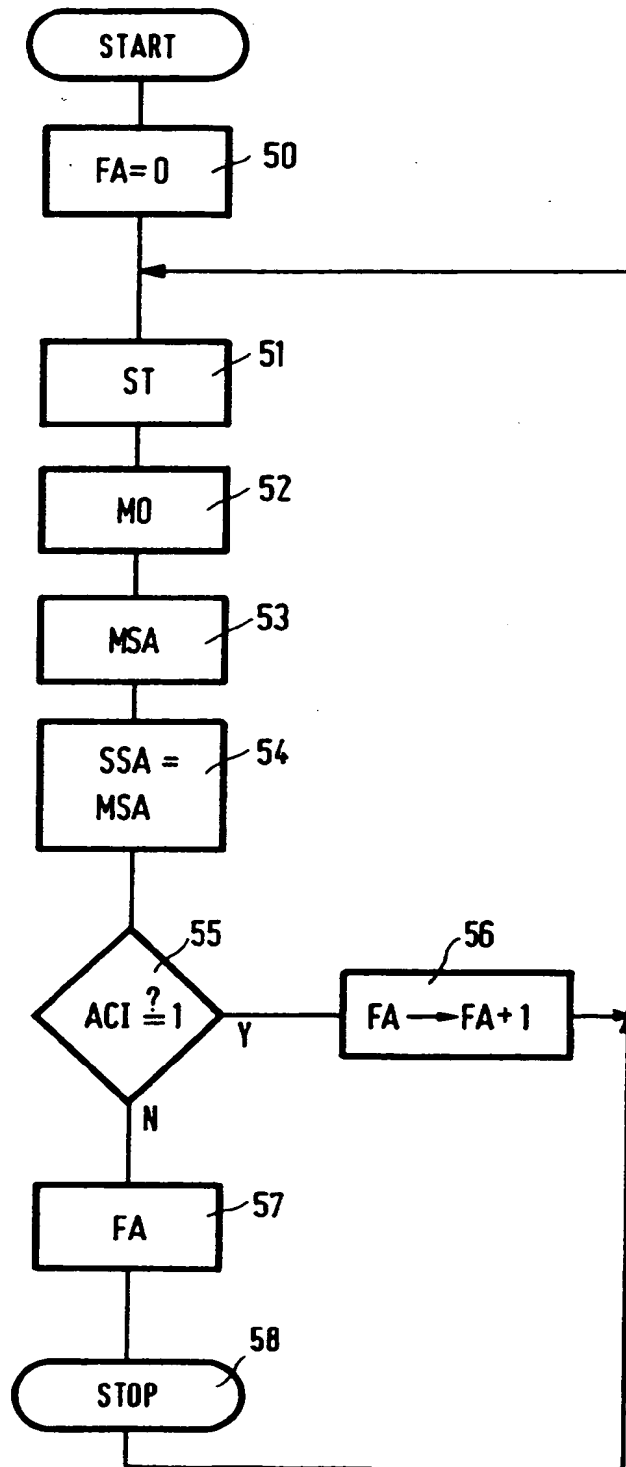


FIG. 3



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# EUROPEAN SEARCH REPORT

Application Number

EP 92 20 2716

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	NL-A-8 900 717 (PHILIPS) * the whole document *	1-10	H04L29/06 H04L12/28
X	GB-A-2 172 778 (APPLE COMPUTER) * page 1, line 105 - line 128 *	1-4	
A		1-10	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H04L H04B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 16 DECEMBER 1992	Examiner CANOSA ARESTE C.
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application I : document cited for other reasons & : member of the same patent family, corresponding document			

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